

## **REMARKS**

In response to the above Office Action, claim 1 has been amended to limit it to the subject of claim 5 which has been cancelled. In addition, the limitation concerning the type and content of the hydrocarbons obtained has been deleted and moved to dependent claim 2. Conforming amendments have been made to the dependent claims where necessary and also to avoid improper multiple dependency. Finally, use claim 11 has been cancelled.

Applicants are not aware of any errors.

A new Declaration is being obtained from Applicants and will be filed in supplement to this Reply.

It is believed the Examiner's objections to the claims and the rejection of the claims under 35 U.S.C. §112, first paragraph on the grounds the specification is only enabling for a Fischer-Tropsch process are now moot in view of the amendments to the claims. It is also believed that the amendments to the claims avoid the noted objections to claims 5, 9 and 10.

In the Office Action, the Examiner also rejected claims 1-8 and 11 under 35 U.S.C. §112, first paragraph on the grounds the specification is not enabling for claims merely reciting an "acidic catalyst," but is enabling for a zeolite component. In this regard it is not understood why the Examiner included claims 7 and 8 in the rejection.

In any event, the present invention is concerned with the combination of the alkali level and  $H_2$  : carbon oxide ratio in order to prevent the migration of one or more promoters to the acid catalyst resulting in the poisoning of the acid site. This is set forth on page 3 of the specification.

The skilled person would appreciate that the disadvantage associated with the poisoning of the acid site of an acid catalyst is true for all acid catalysts, not just an acid catalyst in the form of a zeolite. Further, the skilled person would appreciate that the instant invention is not the type of acid catalyst used, but rather the level of alkali metal and  $H_2$  : carbon oxide ratio used to prevent the above mentioned migration and maximize  $C_{5+}$  products that is important.

In addition, a skilled person in the art would be aware of the type of acid catalysts that would be "suitable" for use in a Fischer-Tropsch process. It is submitted, therefore, that it is not necessary for Applicants to provide examples of every suitable catalyst, especially when the specific nature of the acidic catalyst is not the invention.

Withdrawal of the rejection of the claims under §112, first paragraph is therefore requested.

In the Office Action, the Examiner rejected claims 1-8 under 35 U.S.C. §103(a) for being obvious over U.S. Patent No. 4,361,503 to Dwyer et al., hereafter Dwyer, or U.S. Patent No. 4,304,871 to Brennan et al., hereafter Brennan.

In making this rejection the Examiner first sets forth what she believes is the claimed invention (page 6, lines 6-9 of the Office Action). However, in doing so, the Examiner has omitted the following important features of claim 1, namely that:

- (a) claim 1 refers to carbon oxide rather than carbon monoxide; and
- (b) the reaction mixture contains:
  - (i) less than 0.02 mol alkali metal per 100g iron and
  - (ii) the  $H_2$  : carbon oxide molar ratio in the feed is at least 2.

As stated in the background art of the present application, the combination of a hydrocarbon synthesis catalyst and an acidic catalyst for the preparation of hydrocarbons from syngas is known. However, prior to the present invention, it has not been known that this process can be used for the production of C<sub>5</sub> and heavier hydrocarbons by using the alkali metal levels and H<sub>2</sub> : carbon oxide ratio set out above and in the claims.

The above is particularly unexpected because low levels of alkaline promoter tend to produce light hydrocarbons that are not desirable for gasoline production since they do not fall in the gasoline range of C<sub>5</sub> to C<sub>11</sub> and are not easily converted to this range. It is equally well known that a high H<sub>2</sub> : carbon oxide ratio in the feed favors products which are not desirable for gasoline production and if a low level of alkaline promoter is used a relatively low level ratio of H<sub>2</sub> : carbon oxide should be used.

The present invention improves the production of C<sub>5+</sub> hydrocarbons from syngas in the presence of an alkali promoted iron Fischer-Tropsch catalyst and an acidic catalyst by using the claimed alkali metal level together with the claimed H<sub>2</sub> : carbon oxide molar ratio. These conditions favor less carbon formation in respect of the Fischer Tropsch (FT) catalyst that will result in a greater catalyst life time and at the same time result in the unexpected and favorable production of C<sub>5+</sub> hydrocarbons.

A further important aspect of the claimed combined alkali metal level and H<sub>2</sub> : carbon oxide ratio is that poisoning of the acid sites of the acid catalyst is prevented or substantially lessened such that the combination increases the production of C<sub>5+</sub> hydrocarbons as products.

Dwyer is concerned with an improved process for converting synthesis gas using a conventional FT catalyst and, in particular, with the combined use of a specific crystalline aluminosilicate zeolite as the acid catalyst.

A careful reading of Dwyer shows that aside from recognizing that the FT catalyst may include structural and/or chemical promoters (column 4, lines 9 to 19), no mention is made of the alkali metal level per 100g of iron in the catalyst. This is particularly so in the Examples (column 8 and column 9) wherein it is mentioned that the crystalline aluminosilicate zeolite is intimately mixed with Fe(K) without referring to any amounts. As a result:

- (a) no information is provided in respect of the level of the alkali metal (K) with respect to Fe and accordingly such level cannot be calculated by the skilled person; and
- (b) no statements are made with reference to the level of alkali metal that is to be used in combination with the H<sub>2</sub> : carbon oxide ratio as claimed.

In light of the above, Applicants respectfully submit that it cannot be said that the presently claimed invention is obvious, especially in light of the nature of the invention as described above and the failure of Dwyer to teach or suggest any particular range concerning the alkali metal level.

With respect to the H<sub>2</sub> : carbon oxide ratio claimed, Dwyer contains a very broad statement concerning the ratio as being between 0.5 and 6.0 (column 7, lines 61-62), yet it is silent in the examples as to the exact ratio used. It is submitted, therefore, that a person skilled in the art would not apply the whole range of 0.5 to 6.0 when there is no mention of the alkali metal level since the H<sub>2</sub> : carbon oxide ratio will obviously depend upon this. In other words, the broad range set out in Dwyer would apply to a broad

range of alkali metal levels and the skilled person would rely on his knowledge of the prior art which suggests:

- (a) a low alkali metal level combined with a low H<sub>2</sub> : carbon oxide ratio; or
- (b) a high alkali metal level combined with a high H<sub>2</sub> : carbon oxide ratio.

Further, while Dwyer states that the preferred range is from 1.0 to 2.0 (column 7, line 52), this clearly does not suggest to the skilled person that “at least” a value of 2.0 should be used.

Accordingly, it is not believed that claim 1 or claims 2-4 and 6-10 dependent therefrom are obvious over Dwyer. Its withdrawal as a ground of rejection under §103(a) is therefore requested.

Brennan is concerned with a two stage process wherein in the first stage the FT catalyst (which can be Fe(K)) is mixed with a zeolite which is not acidic (KZSM-5 in Examples 1 to 3). KZSM-5 is a potassium exchanged ZSM-5 and the purpose of the potassium is to eliminate the acidity of the zeolite. This accordingly is not an acidic catalyst as claimed. An acid catalyst is then only used in stage 2 of the process.

It is respectfully pointed out that the Examiner erred in stating that the “promoter amount” taught by the reference appears to overlap that claimed in the instant invention. Column 5, line 26 of Brennan sets out a mol alkali level of less than 0.02 mol alkali per 100g Fe (0.6% K<sub>2</sub>O translates to 0.013 mol alkali per 100g Fe). However, this is given merely as an illustration and importantly in the absence of a corresponding H<sub>2</sub> carbon oxide ratio.

The catalyst disclosed and exemplified in Brennan has a promoter amount of greater than 0.02 mol alkali per 100g iron and, in fact, would disclose a promoter

amount range of from 0.025 mol alkali K/100gFe to 0.077 mol K/100g Fe in the reaction mixture. This is confirmed by the following:

(a) the catalyst composition disclosed in column 10, lines 26-32 of Brennan is as follows:

- (i) 24.5g FeO
- (ii) 69.1g Fe<sub>2</sub>O<sub>3</sub>
- (iii) 2.5g Al<sub>2</sub>O<sub>3</sub>
- (iv) 0.8g K<sub>2</sub>O
- (v) 2.0g CaO
- (vi) 0.4g SiO<sub>2</sub>

(b) that is 100g of the catalyst composition includes:

- (i) 24.5g FeO which is 19g Fe; and
- (ii) 69.1g Fe<sub>2</sub>O<sub>3</sub> which is 48.37g Fe; which means
- (iii) a total amount of Fe of 67.37g of Fe

(c) Since a catalyst of 67.37g Fe contains 0.8g K<sub>2</sub>O, 100g Fe will contain 1.187g K<sub>2</sub>O, which is 0.012 molK<sub>2</sub>O per 100g Fe. This translates to 0.025 mol K per 100g Fe.

The above is clearly greater than “less than 0.02 mol alkali metal per 100g iron” as claimed. This level of alkali metal promoter taught by Brennan is 20% greater than the maximum amount claimed by the Applicants. This is a significant difference considering that hydrocarbon synthesis is very sensitive to alkali metal promotion and effects product selectivity greatly.

Applicants would also like to draw the Examiner's attention to the fact that the presently claimed invention refers to the promoter amount in the reaction mixture. In Brennan and in particular in Examples 1 to 3 thereof, wherein KZSM is used as a co-catalyst, it is clear that 0.95 wt% K is included. This further increases the alkali metal levels above that claimed by the Applicants. According to the Applicants' calculations, the levels of alkali metal in the total reaction mixture would then be about 0.077 mol K/100g Fe, far above the claimed amount of "less than 0.02" in the reaction mixture.

Accordingly, and in light of the above, it is submitted that Brennan does not teach or suggest to the skilled artisan the claimed range of the alkali metal level in the reaction mixture of less than 0.02. Further, and due to the sensitivity of a hydrocarbon synthesis process, Applicants believe it would be hindsight to argue that the skilled person would venture below the limits taught by Brennan.

With respect to the  $H_2$  : carbon oxide ratio, an equally broad statement as that in Dwyer is made concerning this ratio. Consequently, it is submitted that a skilled person would not apply the whole range when an alkali metal level of at least 0.025 mol/100g Fe is taught. A person skilled in the art would consider lowering the  $H_2$  : carbon oxide ratio at lower levels of alkali metal promoter. (This is logical as heavier hydrocarbons contain lower H:C molar ratios than higher hydrocarbons, e.g., in methane ( $CH_4$ ) the H:C molar ratio is 4:1 while in pentane ( $C_5H_{12}$ ) it is 2.4:1. That is, at alkali metal levels of 0.025 mol alkali metal/100g Fe a person skilled in the art would use  $H_2$  : carbon oxide ratios of below 2.)

It is noted in column 3, line 66 to column 4, line 2 of Brennan that the syngas used consists of a mixture of hydrogen gas with gaseous carbon oxides including

carbon monoxide and carbon dioxide. In fact, it would appear that the syngas consists of carbon dioxide at a level of 10% of the carbon monoxide level which translates to a  $H_2$  : carbon oxide ratio of 1.2. This is exactly what the skilled person would expect, namely, that for low levels of alkali promoter, low values of less than 2 for the  $H_2$  : carbon oxide ratio would be expected.

It has been argued above that it is not heretofore known that if a high  $H_2$  : carbon oxide molar ratio and a low level of alkali metal promoter is used (both conditions favoring a very light product) a heavy hydrocarbon product can be obtained. The prior art clearly teaches away from such a combination for producing a relatively heavy hydrocarbon product.

Further, and under such conditions less carbon formation takes place, as mentioned above, which is a common problem and is even identified in Brennan (e.g., at column 2, lines 63 to 67).

Furthermore, in column 10, lines 35-57 Brennan noted:

“While not wishing to be bound by any theory of operations, nevertheless, it appears that in the novel process of this invention, all that is required from the Fischer-Tropsch portion of the catalyst is that it be capable of converting the syngas to an olefinic product at a minimum temperature of at least 450 degrees F . . . [so] that no more than about 30 weight percent of methane plus ethane is formed, . . . .

Thus, it can be seen that the novel process of this invention does not have the same constraints with respect to the use



of Fischer-Tropsch catalyst as existed in heretofore practiced prior art processes. The entire function of the Fischer-Tropsch catalyst in the novel catalyst combination of this invention is merely to produce light olefinic and/or oxygenated hydrocarbons from syngas at good yields and selectively. The particular nature of the intermediate olefins or oxygenated hydrocarbons produced really does not matter too much, since the zeolite can act on this material and transform it to the particular olefinic gasoline with which the novel process of this invention is concerned."

Thus, both Brennan and Dwyer use any suitable Fischer-Tropsch catalyst and a very specific and advanced zeolite catalyst to obtain the required product spectrum. The instant invention uses a very specific and advanced Fischer-Tropsch catalyst with an unconventional  $H_2$  : carbon oxide ratio and any suitable acidic (not necessarily a zeolite) catalyst to obtain the required product stream. The instant invention clearly solves a different problem with a different solution as to what is disclosed in Brennan or Dwyer.

Accordingly, it is not believed that claim 1 or claims 2-4 and 6-10 dependent therefrom are obvious over Brennan. Its withdrawal as a ground of rejection of the claims under §103(a) is therefore requested.

It is submitted that claims 1-4 and 6-10 are in condition for allowance.


In view of the foregoing amendments and remarks, Applicants respectfully request reconsideration and reexamination of this application and the timely allowance of the pending claims.

Please grant any extensions of time required to enter this response and charge any additional required fees to our deposit account 06-0916.

Respectfully submitted,

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